# FORTEC
## ELEKTRONIK AG

**OUR GLOBAL**
**COMPETENCE**
**CENTRES**

APOLLO DISPLAY
TECHNOLOGIES

DISTEC

DISPLAY
TECHNOLOGY

# Datasheet

# Tianma

## NL6448AC18-11D

### 5.7" TFT

NL-01-011

# TFT COLOR LCD MODULE

# NL6448AC18-11D

## 14cm (5.7 Type)
## VGA
## LVDS interface (1port)

## DATA SHEET
**DOD-PP-3345 (5th edition)**

**This DATA SHEET is updated document from DOD-PP-3226(4)**

**All information is subject to change without notice. Please confirm the sales representative before starting to design your system.**

# INTRODUCTION

The Copyright to this document belongs to Tianma Japan, Ltd. (hereinafter called "TMJ"). No part of this document will be used, reproduced or copied without prior written consent of TMJ.

TMJ does and will not assume any liability for infringement of patents, copyrights or other intellectual property rights of any third party arising out of or in connection with application of the products described herein except for that directly attributable to mechanisms and workmanship thereof. No license, express or implied, is granted under any patent, copyright or other intellectual property right of TMJ.

Some electronic products would fail or malfunction at a certain rate. In spite of every effort to enhance reliability of products by TMJ, the possibility of failures and malfunction might not be avoided entirely. To prevent the risks of damage to death, human bodily injury or other property arising out thereof or in connection therewith, each customer is required to take sufficient measures in its safety designs and plans including, but not limited to, redundant system, fire-containment and anti-failure.

The products are classified into three grades: **"Standard"**, **"Special"**, and **"Specific"**.
Each quality grade is designed for applications described below. Any customer who intends to use a product for application other than that of Standard is required to contact a TMJ sales representative in advance.

The **Standard:** Applications as any failure, malfunction or error of the products are free from any damage to death, human bodily injury or other property (Products Safety Issue) and not related the safety of the public (Social Issues), like general electric devices.
Examples: Office equipment, audio and visual equipment, communication equipment, test and measurement equipment, personal electronic equipment, home electronic appliances, car navigation system (with no vehicle control functions), seat entertainment monitor for vehicles and airplanes, fish finder (except marine radar integrated type), PDA, etc.

The **Special:** Applications as any failure, malfunction or error of the products might directly cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and required high level reliability by conventional wisdom.
Examples: Vehicle/train/ship control system, traffic signals system, traffic information control system, air traffic control system, surgery/operation equipment monitor, disaster/crime prevention system, etc.

The **Specific:** Applications as any failure, malfunction or error of the products might severe cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and developed, designed and manufactured in accordance with the standards or quality assurance program designated by the customer who requires extremely high level reliability and quality.
Examples: Aerospace system (except seat entertainment monitor), nuclear control system, life support system, etc.

The quality grade of this product is the **"Standard"** unless otherwise specified in this document.

# CONTENTS

**1. OUTLINE**

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL6448AC18-11D is composed of the amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array and a backlight.

The a-Si TFT LCD panel structure is injected liquid crystal material into a narrow gap between the TFT array glass substrate and a color-filter glass substrate.

Color (Red, Green, Blue) data signals from a host system (e.g. signal generator, etc.) are modulated into best form for active matrix system by a signal processing board, and sent to the driver LSIs which drive the individual TFT arrays.

The TFT array as an electro-optical switch regulates the amount of transmitted light from the backlight assembly, when it is controlled by data signals. Color images are created by regulating the amount of transmitted light through the TFT array of red, green and blue dots.

1.2 APPLICATION

- For industrial use

1.3 FEATURES

- Wide viewing angle
- Wide temperature range
- Reversible-scan direction
- LVDS interface
- Reversible-scan direction
- Long life LED backlight built in LED driver
- Compliant with the European RoHS directive (2011/65/EU) and Delegated Directive (2015/863/EU, Amending Annex II of 2011/65/EU)
- Acquisition product for UL60950-1/CSA-C22.2 No.60950-1-03 (File number: E170632)
- Acquisition product for UL62368-1/CSA C22.2 No.62368-1-14 (File number: E170632)

## 2. GENERAL SPECIFICATIONS

| | |
|---|---|
| *Display area* | 115.2 (H) × 86.4 (V) mm |
| *Diagonal size of display* | 14cm (5.7 inches) |
| *Drive system* | a-Si TFT active matrix |
| *Display color* | 16,194,277 colors |
| *Pixel* | 640 (H) × 480 (V) pixels |
| *Pixel arrangement* | RGB (Red dot, Green dot, Blue dot) vertical stripe |
| *Dot pitch* | 0.06 (H) × 0.18 (V) mm |
| *Pixel pitch* | 0.18 (H) × 0.18 (V) mm |
| *Module size* | 144.0 (W) × 104.6 (H) × 12.3 (D) mm (typ.) |
| *Weight* | 150 g (typ.) |
| *Contrast ratio* | 900:1 (typ.) |
| *Viewing angle* | *At the contrast ratio ≥ 10:1*<br>• Horizontal: Right side 80° (typ.), Left side 80° (typ.)<br>• Vertical: Up side 80° (typ.), Down side 80° (typ.) |
| *Designed viewing direction* | *At DPS= Low or Open: Normal scan*<br>• Viewing direction without image reversal: Down side (6 o'clock)<br>• Viewing direction with contrast peak: Up side (12 o'clock)<br>• Viewing angle with optimum grayscale (γ≒2.2): Normal axis<br>(perpendicular) |
| *Polarizer surface* | Antiglare |
| *Polarizer pencil-hardness* | 3H (min.) [by JIS K5600] |
| *Color gamut* | *At LCD panel center*<br>50% (typ.) [against NTSC color space] |
| *Response time* | *Ton+Toff (10%←→90%)*<br>18ms (typ.) |
| *Luminance* | *At the maximum luminance control*<br>550cd/m$^2$ (typ.) |
| *Signal system* | LVDS interface (1port)<br>8-bit digital signals for data of RGB colors,<br>Dot clock (CLK), Data enable (DE) |
| *Power supply voltage* | LCD panel signal processing board: 3.3V<br>LED driver: 12.0V |
| *Backlight* | LED backlight built in LED driver |
| *Power consumption* | *At the maximum luminance control, Checkered flag pattern*<br>2.4 W (typ.) |

## 3. BLOCK DIAGRAM

Host | LCD module (Product)



- D0+
- D0-  100Ω
- D1+  100Ω
- D1-
- D2+  100Ω
- D2-
- D3+  100Ω
- D3-
- CLK+  100Ω
- CLK-
- DPS

Receiver for LVDS

4.7kΩ

H-driver with timing controller

1,920 lines

480 lines

LCD panel
H: 640 × 3 (R, G, B)
V: 480

V-driver

Power supply for gradation

- GND
  Note1
  Note2
- VCC
- VDD
- PWM
- BRTC
- GND
- FG
  Note1
  Note2

Fuse

1kΩ

1kΩ

100kΩ  100kΩ

42kΩ

42kΩ

DC/DC converter

LED driver

LED Backlight

LCD panel signal processing board

Note1: Relation between GND (Signal ground and LED driver ground) and FG (Frame ground) in the LCD module is as follows.

| GND - FG | Connected |
|---|---|

Note2: GND and FG must be connected to customer equipment's ground, and it is recommended that these grounds to be connected together in customer equipment.

## 4. DETAILED SPECIFICATIONS

### 4.1 MECHANICAL SPECIFICATIONS

| Parameter | Specification | | Unit |
|---|---|---|---|
| Module size | 144.0 ± 0.5 (W) × 104.6 ± 0.5 (H) × 12.3± 0.5 (D) | Note1 | mm |
| Display area | 115.2 (H) × 86.4(V) | Note1 | mm |
| Weight | 150 (typ.), 165 (max.) | | g |

Note1:  See "**8. OUTLINE DRAWINGS**".

### 4.2 ABSOLUTE MAXIMUM RATINGS

| Parameter | | | Symbol | Rating | Unit | Remarks |
|---|---|---|---|---|---|---|
| Power supply voltage | LCD panel signal processing board | | VCC | -0.3 to +5.0 | V | Ta = 25°C |
| | LED driver | | VDD | -0.3 to +15.0 | | |
| Input voltage for signals | LCD panel signal processing board | Display signals Note1 | VD | -0.3 to VCC+0.3 | V | |
| | | Function signals Note2 | VF | | | |
| | LED driver | | PWM | -0.3 to +5.5 | V | |
| | | | BRTC | -0.3 to +VDD+0.1 | V | |
| Storage temperature | | | Tst | -30 to +85 | °C | - |
| Operating temperature | Front surface | | TopF | -30 to +85 | °C | Note3 |
| | Rear surface | | TopR | -30 to +85 | °C | Note4 |
| Relative humidity Note5 | | | RH | ≤ 95 | % | Ta ≤ 40°C |
| | | | | ≤ 85 | % | 40°C < Ta ≤ 50°C |
| | | | | ≤ 55 | % | 50°C < Ta ≤ 60°C |
| | | | | ≤ 36 | % | 60°C < Ta ≤ 70°C |
| | | | | ≤ 24 | % | 70°C < Ta ≤ 80°C |
| | | | | ≤ 20 | % | 80°C < Ta ≤ 85°C |
| Absolute humidity Note5 | | | AH | ≤ 70 Note6 | g/m³ | Ta= 85°C |

Note1:  D0+/-, D1+/-, D2+/-, D3+/-, CLK+/-
Note2:  DPS
Note3:  Measured at LCD panel surface (including self-heat)
Note4:  Measured at LCD module's rear shield surface (including self-heat)
Note5:  No condensation
Note6:  Water amount at Ta= 85°C and RH= 20%

## 4.3 ELECTRICAL CHARACTERISTICS

### 4.3.1 LCD panel signal processing board

(Ta= 25°C, Note1)

| Parameter | | Symbol | min. | typ. | max. | Unit | Remarks |
|---|---|---|---|---|---|---|---|
| Power supply voltage | | VCC | 3.0 | 3.3 | 3.6 | V | - |
| Power supply current | | ICC | - | 180 Note2 | 270 Note3 | mA | at VCC= 3.3V |
| Permissible ripple voltage | | VRPC | - | - | 100 | mVp-p | for VCC Note4, Note5, Note6 |
| Differential input threshold voltage | High | VTH | - | - | +100 | mV | at VCM= 1.2 V Note7 |
| | Low | VTL | -100 | - | - | | |
| Terminating resistance | | RT | - | 100 | - | Ω | - |
| Input voltage for DPS signal | High | VFH | 0.7VCC | - | VCC | V | CMOS level |
| | Low | VFL | 0 | - | 0.3VCC | | |
| Input current for DPS signal | High | IFH | - | - | 800 | μA | - |
| | Low | IFL | -800 | - | - | | |

Note1: When designing of the power supply, take the measures for the prevention of surge voltage.
Note2: Checkered flag pattern [by IEC 61747-6]
Note3: Pattern for maximum current
Note4: This product works even if the ripple voltage levels are over the permissible values, but there might be noise on the display image.
Note5: The permissible ripple voltage includes spike noise.
Note6: The load variation influence does not include.
Note7: Common mode voltage for LVDS receiver

### 4.3.2 LED driver

(Ta= 25°C, Note1)

| Parameter | | Symbol | min. | typ. | max. | Unit | Remarks |
|---|---|---|---|---|---|---|---|
| Power supply voltage | | VDD | 10.8 | 12.0 | 13.2 | V | - |
| Power supply current | | IDD | - | 150 | 190 Note2 | mA | at VDDB= 12.0V, at the maximum luminance control |
| Permissible ripple voltage | | VRPD | - | - | 200 | mVp-p | for VDD Note3, Note4, Note5 |
| Input voltage for PWM signal | High | VDFH1 | 2.0 | - | 5.3 | V | Note6 |
| | Low | VDFL1 | - | - | 0.8 | V | |
| Input voltage for BRTC signal | High | VDFH2 | 2.0 | - | VDD | V | |
| | Low | VDFL2 | - | - | 0.8 | V | |
| Input current for PWM signal | High | IDFH1 | - | - | 300 | μA | Note6 |
| | Low | IDFL1 | -300 | - | - | μA | |
| Input current for BRTC signal | High | IDFH2 | - | - | 500 | μA | |
| | Low | IDFL2 | -500 | - | - | μA | |
| PWM frequency | | f$_{PWM}$ | 200 | - | 10k | Hz | Note7, Note8 |
| PWM duty ratio | | DR$_{PWM}$ | 1 | - | 100 | % | Note9, Note10 |
| PWM pulse width | | tPWH | 1 | - | - | μs | |

Note1: When designing of the power supply, take the measures for the prevention of surge voltage.

Note2: This value excludes peak current such as overshoot current.

Note3: This product works even if the ripple voltage levels are over the permissible values, but there might be noise on the display image.

Note4: The permissible ripple voltage includes spike noise.

Note5: The power supply lines (VDD and GND) may have ripple voltage during luminance control of LED. There is the possibility that the ripple voltage produces acoustic noise and signal wave noise in audio circuit and so on.

Note6: See "**3. BLOCK DIAGRAM**".

Note7: A recommended f$_{PWM}$ value is as follows.

$$f_{PWM} = \frac{2n-1}{4} \times fv$$

(n = integer, fv = frame frequency of LCD module)

Note8: Depending on the frequency used, some noise may appear on the screen, please conduct a thorough evaluation.

Note9: While the BRTC signal is high, do not set the tPWH (PWM pulse width) is less than minimum value. It may cause abnormal working of the backlight. In this case, turn the backlight off and then on again by BRTC signal.

Note10: Regardless of the PWM frequency, both PWM duty ratio and PWM pulse width must be always more than the minimum values.

### 4.3.3 Fuse

| Parameter | Fuse | | Rating | Fusing current | Remarks |
|---|---|---|---|---|---|
| | Type | Supplier | | | |
| VCC | FCC16152AB | KAMAYA ELECTRIC CO.,LTD | 1.5A | 3.0A | Note1 |
| | | | 36V | | |
| VDD | FCC16152AB | KAMAYA ELECTRIC CO.,LTD | 1.5A | 3.0A | |
| | | | 36V | | |

Note1: The power supply's rated current must be more than the fusing current. If it is less than the fusing current, the fuse may not blow in a short time, and then nasty smell, smoke and so on may occur.

### 4.4 POWER SUPPLY VOLTAGE SEQUENCE

4.4.1 LCD panel signal processing board
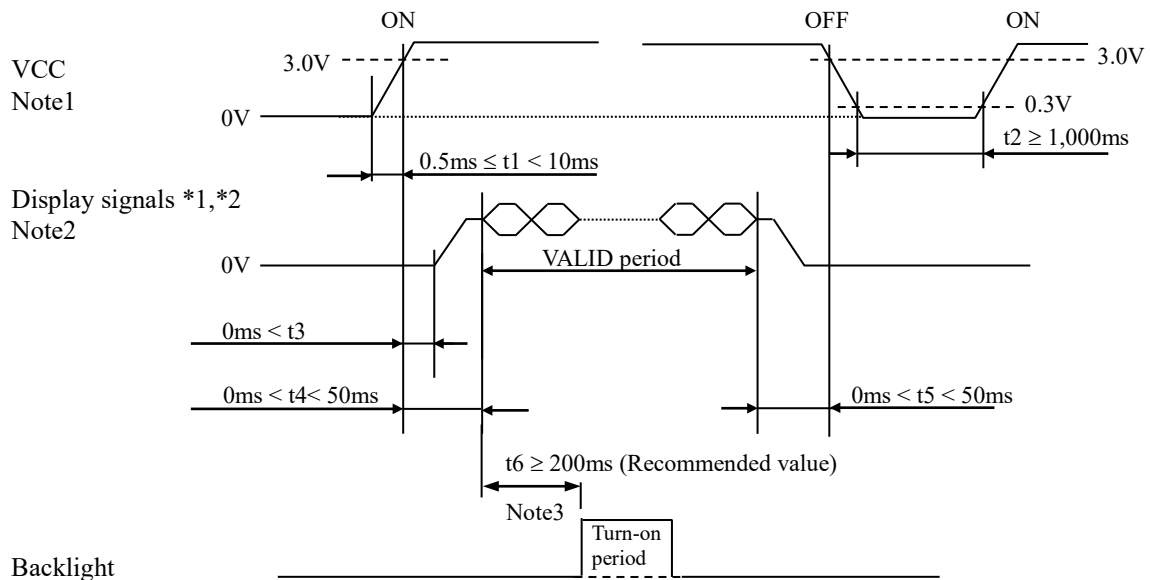


*1 D0+/-, D1+/-, D2+/-, D3+/-, CLK+/-
*2 These signals should be measured at the terminal of $100\Omega$ resistance.

Note1: If there is a voltage variation (voltage drop) at the rising edge of VCC below 3.0V, there is a possibility that a product does not work due to a protection circuit.
Note2: Display signals (D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-) and function signals (DPS) must be set to Low or High-impedance, except the VALID period (See above sequence diagram), in order to avoid the circuitry damage.
If some of display and function signals of this product are cut while this product is working, even if the signal input to it once again, it might not work normally. If a customer stops the display and function signals, VCC also must be shut down.
Note3: In order to avoid unstable data display, the backlight is recommended to turn on within the valid of display and function signals.
Recommended value: $t6 \geq 200ms$

4.4.2 LED driver
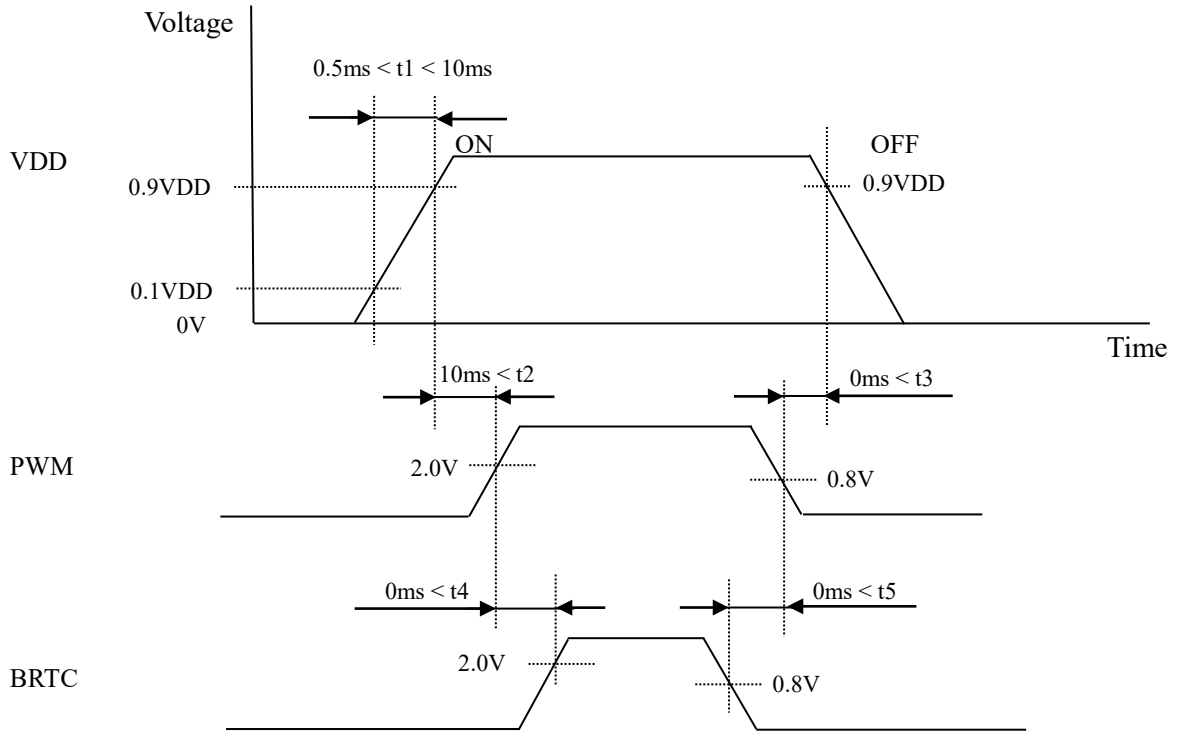


Note1: The backlight should be turned on within the valid period of display and function signals, in order to avoid unstable data display.

## 4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

### 4.5.1 LCD panel signal processing board

CN1 socket (LCD module side):  FI-SE20P-HFE (Japan Aviation Electronics Industry Limited (JAE))
Adaptable plug:                FI-S20S        (Japan Aviation Electronics Industry Limited (JAE))

| Pin No. | Symbol | Signal | Remarks |
|---|---|---|---|
| 1 | D3+ | Pixel data (R6-R7,G6-G7,B6-B7) | Note2, Note4 |
| 2 | D3- | | |
| 3 | DPS | Selection of scan direction | High :                Reverse scan<br>Low or Open :    Normal scan        Note3 |
| 4 | N.C. | - | Keep this pin Open. |
| 5 | GND | Ground | Note1 |
| 6 | CLK+ | Pixel clock | Note2 |
| 7 | CLK- | | |
| 8 | GND | Ground | Note1 |
| 9 | D2+ | Pixel data (B2-B5,DE) | Note2, Note4 |
| 10 | D2- | | |
| 11 | GND | Ground | Note1 |
| 12 | D1+ | Pixel data (G1-G5,B0-B1) | Note2, Note4 |
| 13 | D1- | | |
| 14 | GND | Ground | Note1 |
| 15 | D0+ | Pixel data (R0-R5,G0) | Note2, Note4 |
| 16 | D0- | | |
| 17 | GND | Ground | Note1 |
| 18 | GND | | |
| 19 | VCC | Power supply | Note1 |
| 20 | VCC | | |

Note1:  All GND and VCC terminals should be used without any non-connected lines.
Note2:  See "**4.6 DISPLAY COLORS AND INPUT DATA SIGNALS**".
Note3:  See "**4.8 SCANNING DIRECTIONS**".
Note4:  Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

### 4.5.2 LED driver

CN2 socket (LCD module side):  SM06B-SRSS-TB(LF)(SN) (JST Co. Ltd)
Adaptable plug:                          SHR-06V-S-B (JST Co. Ltd)

| Pin No. | Symbol | Function | Remarks |
|---------|--------|----------|---------|
| 1 | VDD | Power supply | Note1 |
| 2 | VDD | Power supply | |
| 3 | GND | Ground | |
| 4 | GND | Ground | |
| 5 | PWM | Luminance control | PWM Dimming<br>Open: Max. Luminance |
| 6 | BRTC | Backlight ON/OFF control | High or Open:     Backlight ON<br>Low:             Backlight OFF |

Note1:  All VDD and GND terminals should be used without any non-connected lines.

### 4.5.3 Positions of socket

Rear side

4.5.4 Input data mapping



Note1: LSB (Least Significant Bit) – R0, G0, B0    MSB (Most Significant Bit) – R7, G7, B7

Note2: Twist pair wires with $100\,\Omega$ (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
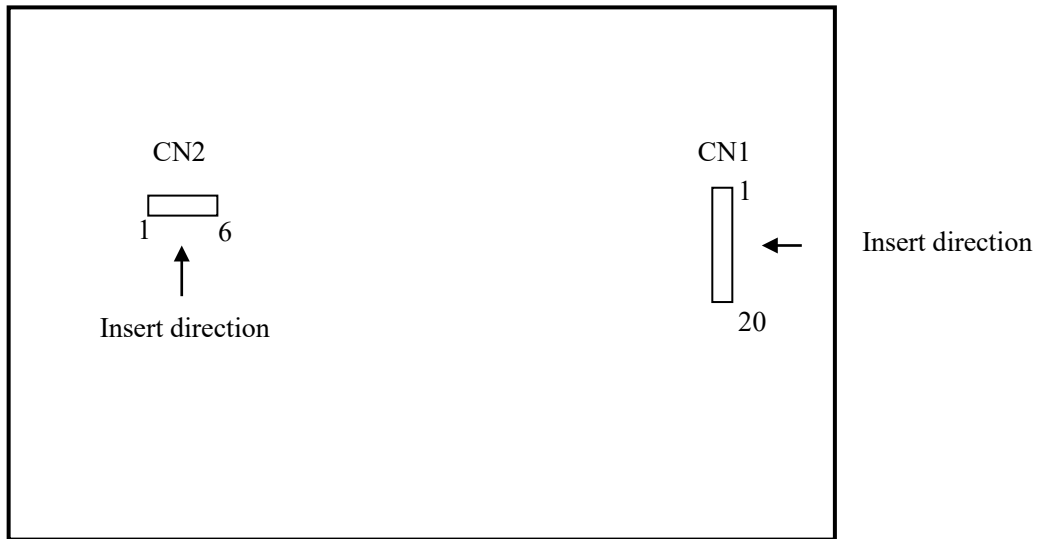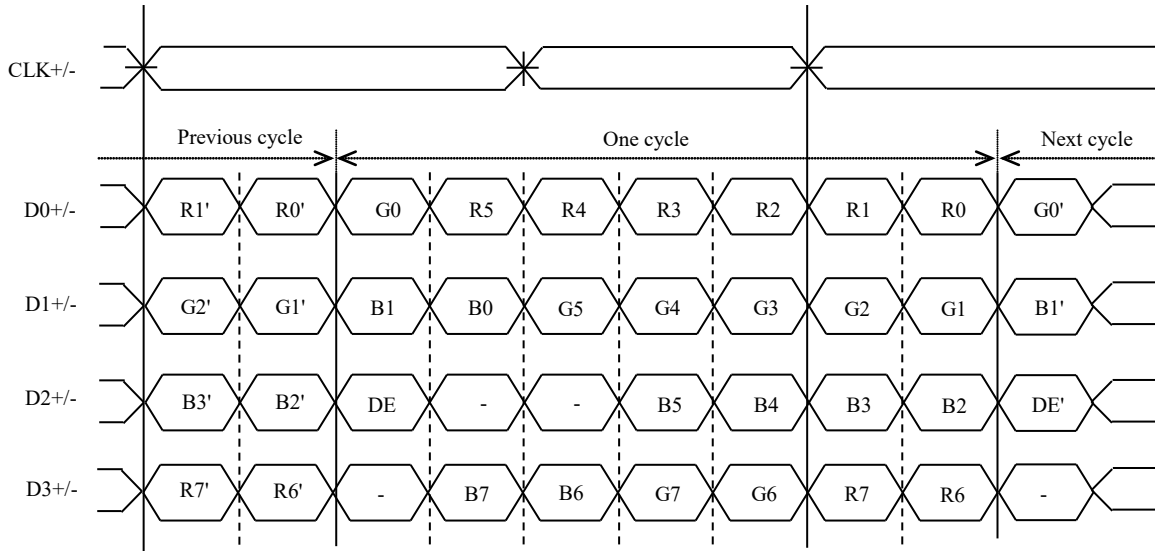
## 4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display 16,194,277 colors with 253 gray scales. Also the relation between display colors and input data signals is as follows.

(Note1)

| Display colors | | R7 | R6 | R5 | R4 | R3 | R2 | R1 | R0 | G7 | G6 | G5 | G4 | G3 | G2 | G1 | G0 | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Data signal (0: Low level, 1: High level) | | | | | | | | | | | | | | | | | | | | | | |
| Basic Colors | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Blue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | x | x |
| | Red | 1 | 1 | 1 | 1 | 1 | 1 | x | x | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Magenta | 1 | 1 | 1 | 1 | 1 | 1 | x | x | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | x | x |
| | Green | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | x | x | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Cyan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | x | x | 1 | 1 | 1 | 1 | 1 | 1 | x | x |
| | Yellow | 1 | 1 | 1 | 1 | 1 | 1 | x | x | 1 | 1 | 1 | 1 | 1 | 1 | x | x | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | White | 1 | 1 | 1 | 1 | 1 | 1 | x | x | 1 | 1 | 1 | 1 | 1 | 1 | x | x | 1 | 1 | 1 | 1 | 1 | 1 | x | x |
| Red gray scale | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | dark | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | ↑ | | | | : | | | | | | | | : | | | | | | | | : | | | | |
| | ↓ | | | | : | | | | | | | | : | | | | | | | | : | | | | |
| | bright | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red | 1 | 1 | 1 | 1 | 1 | 1 | x | x | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Green gray scale | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | dark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | ↑ | | | | : | | | | | | | | : | | | | | | | | : | | | | |
| | ↓ | | | | : | | | | | | | | : | | | | | | | | : | | | | |
| | bright | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | x | x | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Blue gray scale | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | dark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | ↑ | | | | : | | | | | | | | : | | | | | | | | : | | | | |
| | ↓ | | | | : | | | | | | | | : | | | | | | | | : | | | | |
| | bright | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| | Blue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | x | x |

Note1: X means 0 or 1.

## 4.7 DISPLAY POSITIONS

D (1, 1)

| R | G | B |
|---|---|---|

| D( 1, 1) | D( 2, 1) | · · · | D( X, 1) | · · · | D(639, 1) | D(640, 1) |
|---|---|---|---|---|---|---|
| D( 1, 2) | D( 2, 2) | · · · | D( X, 2) | · · · | D(639, 2) | D(640, 2) |
| · | · | · | · | · | · | · |
| · | · | · · · | · | · · · | · | · · · |
| · | · | · | · | · | · | · |
| D( 1, Y) | D( 2, Y) | · · · | D( X, Y) | · · · | D(639, Y) | D(640, Y) |
| · | · | · | · | · | · | · |
| · | · | · · · | · | · · · | · | · |
| · | · | · | · | · | · | · |
| D( 1, 479) | D( 2, 479) | · · · | D( X, 479) | · · · | D(639, 479) | D(640, 479) |
| D( 1, 480) | D( 2, 480) | · · · | D( X, 480) | · · · | D(639, 480) | D(640, 480) |

Note1: See "**4.8 SCANNING DIRECTIONS**".

## 4.8 SCANNING DIRECTIONS

The following figures are seen from a front view.
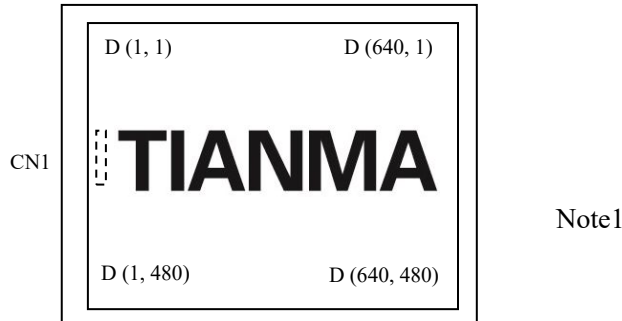


Figure1. Normal scan (DPS: Low or Open)
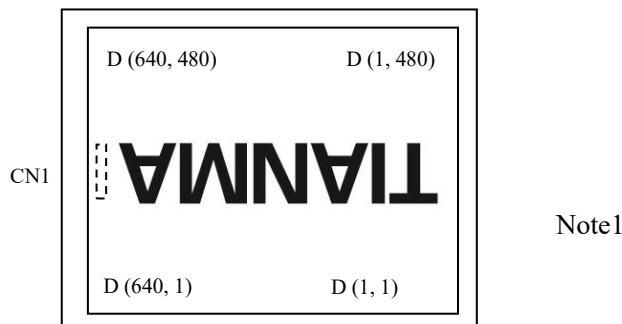


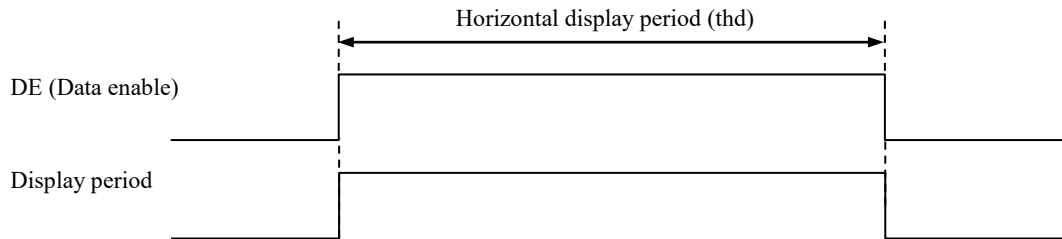Figure2. Reverse scan (DPS: High)

Note1: Meaning of D (X, Y)
D (X, Y):Input data signals for LCD panel signal processing board

4.9 INPUT SIGNAL TIMINGS
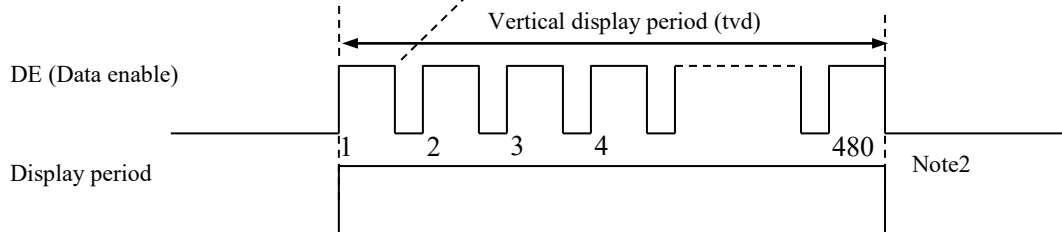
4.9.1 Outline of input signal timings

• Horizontal signal

Note1



• Vertical signal

Note1

Note1: This diagram indicates virtual signal for set up to timing.
Note2: See "**4.9.3 Input signal timing chart**" for the pulse number.

## 4.9.2 Timing characteristics

| Parameter | | | Symbol | min. | typ. | max. | Unit | Remarks |
|---|---|---|---|---|---|---|---|---|
| CLK | Frequency | | 1/tc | 24.8 | 25.2 | 34.2 | MHz | 39.68ns (typ.) |
| | Duty ratio | | - | | - | | - | - |
| DATA (R0-R7) (G0-G7) (B0-B7) | CLK-DATA | Setup time | - | | | | ns | - |
| | | Hold time | - | | - | | ns | |
| DE | Horizontal | Cycle | th | 29.240 | 31.746 | 32.258 | μs | 31.5 kHz (typ.) |
| | | | | 800 | 800 | 1,000 | CLK | |
| | | Display period | thd | | 640 | | CLK | - |
| | Vertical (One frame) | Cycle | tv | 15.351 | 16.667 | 16.935 | ms | 60.0 Hz (typ.) |
| | | | | 516 | 525 | 570 | H | |
| | | Display period | tvd | | 480 | | H | - |
| | CLK-DE | Setup time | - | | | | ns | - |
| | | Hold time | - | | - | | ns | |

Note1: Definition of parameters is as follows.
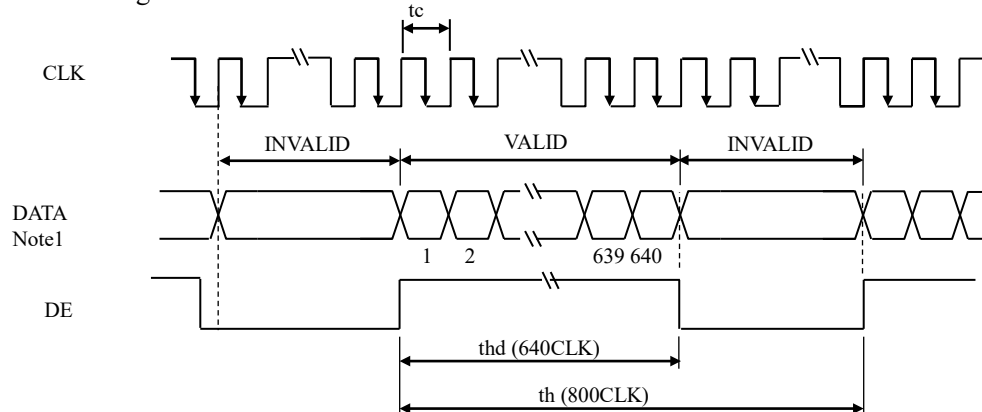       tc= 1CLK, th= 1H
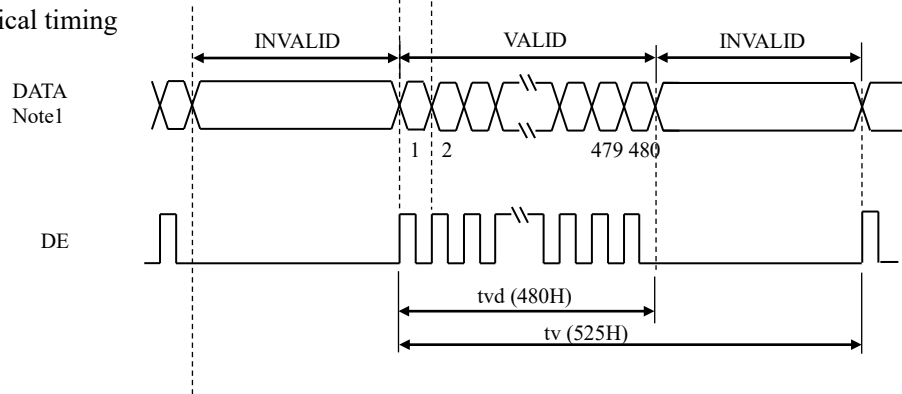Note2: See the data sheet of LVDS transmitter.
Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

4.9.3 Input signal timing chart

Horizontal timing



Vertical timing



Note1: DATA = R0-R7, G0-G7, B0-B7

**TIANMA**

## 4.10 LVDS Rx AC SPEC

| Symbol | Parameter | min. | typ. | max. | Units |
|---|---|---|---|---|---|
| $t_{RCIP}$ | CLK_P+ Period | 29.24 | - | 40.32 | ns |
| $t_{RCIH}$ | CLK_P+ High pulse width | - | $\frac{4}{7} t_{RCIP}$ | - | ns |
| $t_{RCIL}$ | CLK_P+ Low pulse width | - | $\frac{3}{7} t_{RCIP}$ | - | ns |
| $t_{RMG}$ | Receiver Data Input Margin | -0.4 | - | 0.4 | ns |
| $t_{RIP1}$ | Input Data Position0 | $-\lvert t_{RMG}\rvert$ | 0.0 | $+\lvert t_{RMG}\rvert$ | ns |
| $t_{RIP0}$ | Input Data Position1 | $\frac{t_{RCIP}}{7} - \lvert t_{RMG}\rvert$ | $\frac{t_{RCIP}}{7}$ | $\frac{t_{RCIP}}{7} + \lvert t_{RMG}\rvert$ | ns |
| $t_{RIP6}$ | Input Data Position2 | $2\frac{t_{RCIP}}{7} - \lvert t_{RMG}\rvert$ | $2\frac{t_{RCIP}}{7}$ | $2\frac{t_{RCIP}}{7} + \lvert t_{RMG}\rvert$ | ns |
| $t_{RIP5}$ | Input Data Position3 | $3\frac{t_{RCIP}}{7} - \lvert t_{RMG}\rvert$ | $3\frac{t_{RCIP}}{7}$ | $3\frac{t_{RCIP}}{7} + \lvert t_{RMG}\rvert$ | ns |
| $t_{RIP4}$ | Input Data Position4 | $4\frac{t_{RCIP}}{7} - \lvert t_{RMG}\rvert$ | $4\frac{t_{RCIP}}{7}$ | $4\frac{t_{RCIP}}{7} + \lvert t_{RMG}\rvert$ | ns |
| $t_{RIP3}$ | Input Data Position5 | $5\frac{t_{RCIP}}{7} - \lvert t_{RMG}\rvert$ | $5\frac{t_{RCIP}}{7}$ | $5\frac{t_{RCIP}}{7} + \lvert t_{RMG}\rvert$ | ns |
| $t_{RIP2}$ | Input Data Position6 | $6\frac{t_{RCIP}}{7} - \lvert t_{RMG}\rvert$ | $6\frac{t_{RCIP}}{7}$ | $6\frac{t_{RCIP}}{7} + \lvert t_{RMG}\rvert$ | ns |
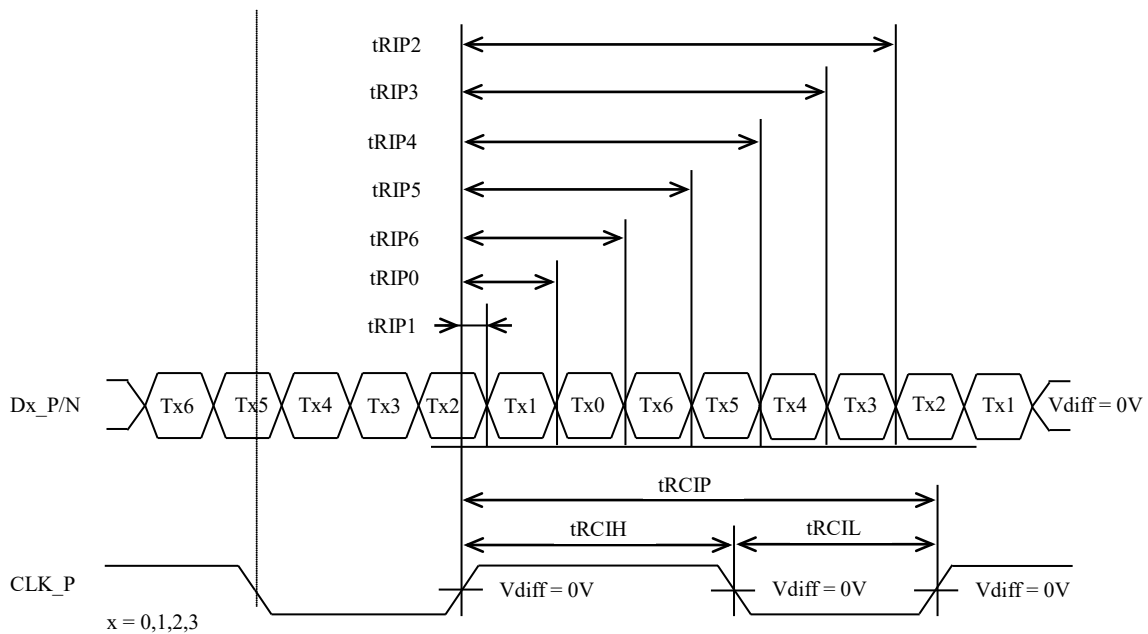
## 4.11 OPTICS

### 4.11.1 Optical characteristics

(Note1, Note2)

| Parameter | | Condition | Symbol | min. | typ. | max. | Unit | Measuring instrument | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Luminance | | White at center θR= 0°, θL= 0°,θU= 0°,θD= 0° | L | 400 | 550 | - | cd/m$^2$ | BM-5A or equivalent | - |
| Contrast ratio | | White/Black at center θR= 0°, θL= 0°,θU= 0°,θD= 0° | CR | 500 | 900 | - | - | BM-5A or equivalent | Note3 |
| Luminance uniformity | | White θR= 0°, θL= 0°,θU= 0°,θD= 0° | LU | - | 1.25 | 1.4 | - | BM-5A or equivalent | Note4 |
| Chromaticity | White | **x** coordinate | Wx | 0.263 | 0.313 | 0.363 | - | SR-3 or equivalent | Note5 |
| | | **y** coordinate | Wy | 0.279 | 0.329 | 0.379 | - | | |
| | Red | **x** coordinate | Rx | - | 0.605 | - | - | | |
| | | **y** coordinate | Ry | - | 0.348 | - | - | | |
| | Green | **x** coordinate | Gx | - | 0.328 | - | - | | |
| | | **y** coordinate | Gy | - | 0.576 | - | - | | |
| | Blue | **x** coordinate | Bx | - | 0.144 | - | - | | |
| | | **y** coordinate | By | - | 0.120 | - | - | | |
| Color gamut | | θR= 0°, θL= 0°,θU= 0°,θD= 0° at center, against NTSC color space | C | 45 | 50 | - | % | | |
| Response time | | White to Black | Ton | - | 3 | 5 | ms | BM-5A or equivalent | Note6 Note7 |
| | | Black to White | Toff | - | 15 | 21 | ms | | |
| Viewing angle | Right | θU= 0°, θD= 0°, CR≥ 10 | θR | 70 | 80 | - | ° | EZ Contrast | Note8 |
| | Left | θU= 0°, θD= 0°, CR≥ 10 | θL | 70 | 80 | - | ° | | |
| | Up | θR= 0°, θL= 0°, CR≥ 10 | θU | 70 | 80 | - | ° | | |
| | Down | θR= 0°, θL= 0°, CR≥ 10 | θD | 70 | 80 | - | ° | | |

Note1: These are initial characteristics.
Note2: Measurement conditions are as follows.
  Ta = 25°C, VCC = 3.3V, VDD = 12.0V, PWM duty ratio: 100%,
  Display mode: VGA, Horizontal cycle = 1/31.5kHz, Vertical cycle = 1/60.0Hz,
  DPS= Low or Open: Normal scan

  Optical characteristics are measured at luminance saturation 20minutes after the product works, in the dark room. Also measurement methods are as follows.
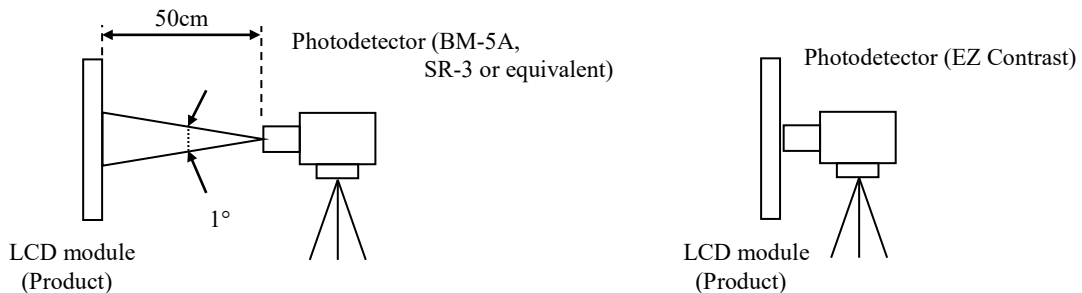


Note3: See "**4.11.2 Definition of contrast ratio**".
Note4: See "**4.11.3 Definition of luminance uniformity**".
Note5: These coordinates are found on CIE 1931 chromaticity diagram.
Note6: Product surface temperature: TopF= 28°C
Note7: See "**4.11.4 Definition of response times**".
Note8: See "**4.11.5 Definition of viewing angles**".

4.11.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.11.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

The luminance is measured at near the 5 points shown below.
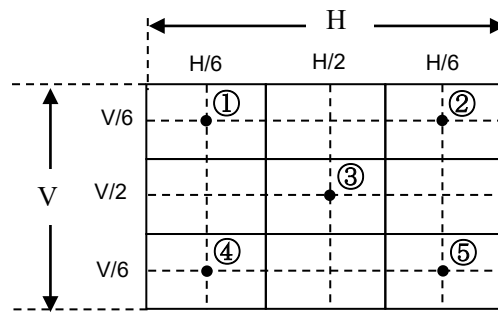
4.11.4 Definition of response times

Response time is measured at the time when the luminance changes from "white" to "black", or "black" to "white" on the same screen point, by photo-detector. Ton is the time when the luminance changes from 90% down to 10%. Also Toff is the time when the luminance changes from 10% up to 90% (See the following diagram.).
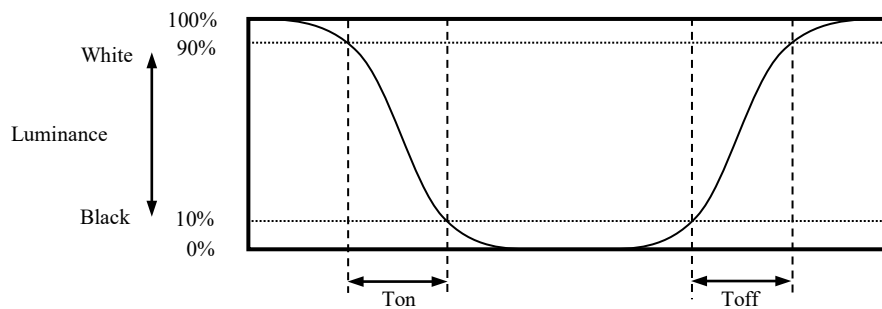
4.11.5 Definition of viewing angles
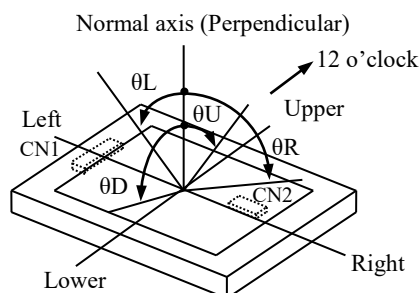
## 5. ESTIMATED LUMINANCE LIFETIME

The luminance lifetime is the time from initial luminance to half-luminance.

**This lifetime is the estimated value, and is not guarantee value.**

| Condition | | Estimated luminance lifetime (Life time expectancy) Note1, Note2, Note3 | Unit |
|---|---|---|---|
| LED elementary substance | 25°C (Ambient temperature of the product) Continuous operation, PWM duty ratio: 100% | 70,000 | h |
| | 85°C (Temperature of LCD panel surface and rear shield surface) Continuous operation, PWM duty ratio: 100% | 40,000 | |

Note1: Life time expectancy is mean time to half-luminance.
Note2: Estimated luminance lifetime is not the value for LCD module but the value for LED elementary substance.
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.

## 6. RELIABILITY TESTS

| Test item | Condition | Judgment          Note1 |
|---|---|---|
| High temperature (Operation) | ① +85 ± 3°C, 240 hours<br>② Display data is black. | No display malfunctions (The polarizer discoloration is allowed. But no peeling the polarizer off is recognized.) |
| Heat cycle (Operation) | ① -30 ± 3°C…1 hour<br> +85 ± 3°C…1 hour<br>② 50 cycles, 4 hours/cycle<br>③ Display data is black. | |
| Thermal shock (Non operation) | ① -30 ± 3°C…30 minutes<br> +85 ± 3°C…30 minutes<br>② 100cycles, 1 hour/cycle<br>③ Temperature transition time is within 5 minutes. | |
| High temperature and humidity (Operation) | ① +60 ± 2°C, RH= 90%, 240 hours<br>② Display data is black. | No display malfunctions |
| ESD (Operation) | ① 150pF, 150Ω, ±10kV<br>② 9 places on a panel surface      Note2<br>③ 10 times each place at 1 sec interval | |
| Dust (Operation) | ① Sample dust: No. 15 (by JIS-Z8901)<br>② 15 seconds stir<br>③ 8 times repeat at 1 hour interval | |
| Vibration (Non operation) | ① 5 to 100Hz, 19.6m/s$^2$<br>② 1 minute/cycle<br>③ X, Y, Z directions<br>④ 120 times each direction | No display malfunctions<br>No physical damages |
| Mechanical shock (Non operation) | ① 539m/s$^2$, 11ms<br>② ±X, ±Y, ±Z directions<br>③ 5 times each direction | |

Note1: Display and appearance are checked under environmental conditions equivalent to the inspection conditions of defect criteria.

Note2: See the following figure for discharge points.
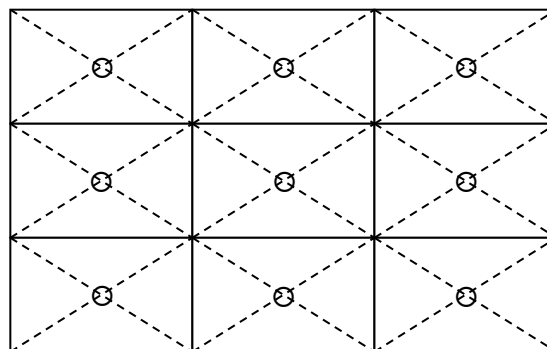
## 7. PRECAUTIONS

### 7.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "7.2 CAUTIONS" and "7.3 ATTENTIONS"!**

| ⚠ ! | This sign has the meaning that a customer will be injured or the product will sustain damage if the customer practices wrong operations. |
|---|---|

| ⚠ | This sign has the meaning that a customer will be injured if the customer practices wrong operations. |
|---|---|

### 7.2 CAUTIONS

⚠

* **Do not shock and press the LCD panel and the backlight! There is a danger of breaking, because they are made of glass. (Shock: Equal to or no greater than 539m/s$^2$ and equal to or no greater than 11ms, Pressure: Equal to or no greater than 19.6N ($\phi$16mm jig))**

### 7.3 ATTENTIONS ⚠!

#### 7.3.1 Handling of the product

① Take hold of both ends without touching the circuit board when the product (LCD module) is picked up from inner packing box to avoid broken down or misadjustment, because of stress to mounting parts on the circuit board.

② Do not hook nor pull cables such as lamp cable, and so on, in order to avoid any damage.

③ When the product is put on the table temporarily, display surface must be placed downward.

④ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.

⑤ The torque for product mounting screws must never exceed 0.200 N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be ≤ 3.5 mm.

⑥ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area). Bends or twist described above and undue stress to any portion may cause display mura.

⑦ Do not press or rub on the sensitive product surface. When cleaning the panel surface, wipe it with a soft dry cloth.

⑧ Do not push or pull the interface connectors while the product is working.

⑨ When handling the product, use of an original protection sheet on the product surface (polarizer) is recommended for protection of product surface. Adhesive type protection sheet may change color or characteristics of the polarizer.

⑩ Usually liquid crystals don't leak through the breakage of glasses because of the surface tension of thin layer and the construction of LCD panel. But, if you contact with liquid crystal by any chance, please wash it away with soap and water.

7.3.2 Environment

① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in packing box with antistatic pouch in room temperature to avoid dusts and sunlight, when storing the product.

② In order to prevent dew condensation occurred by temperature difference, the product packing box must be opened after enough time being left under the environment of an unpacking room. Evaluate the storage time sufficiently because dew condensation is affected by the environmental temperature and humidity. (Recommended leaving time: 6 hours or more with the original packing state after a customer receives the package)

③ Do not operate in high magnetic field. If not, circuit boards may be broken.

④ This product is not designed as radiation hardened.

7.3.3 Characteristics

**The following items are neither defects nor failures.**

① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough time being left under condition of operating temperature.

② Display mura, flickering, vertical streams or tiny spots may be observed depending on display patterns.

③ Do not display the fixed pattern for a long time because it may cause image sticking. Use a screen saver, if the fixed pattern is displayed on the screen.

④ The display color may be changed depending on viewing angle because of the use of condenser sheet in the backlight.

⑤ Optical characteristics may be changed depending on input signal timings.

7.3.4 Others

① All GND, VCC and VDD terminals should be used without any non-connected lines.

② Do not disassemble a product or adjust variable resistors.

③ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to TMJ.

④ Pay attention not to enter foreign materials inside of the product, when using tapping screws.

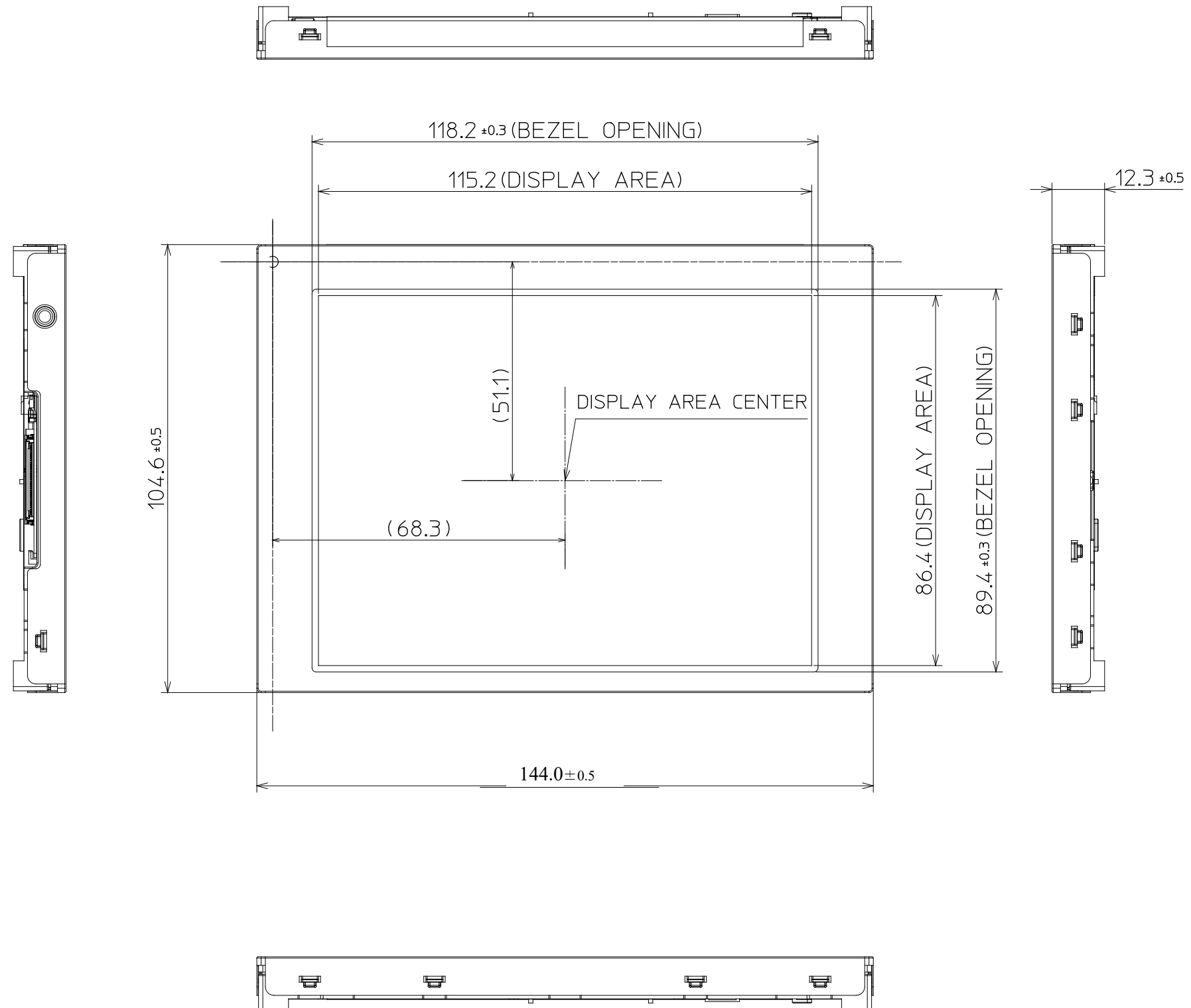⑤ The information of China RoHS (Ⅱ) six hazardous substances or elements in this product is as follows.

| China RoHS (Ⅱ) six hazardous substances or elements | | | | | |
|---|---|---|---|---|---|
| Lead (Pb) | Mercury (Hg) | Cadmium (Cd) | Hexavalent Chromium (Cr VI) | Polybrominated Biphenys (PBB) | Polybrominated Biphenyl Ethers (PBDE) |
| ✕ | ○ | ○ | ○ | ○ | ○ |

Note1: ○: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is equal or below the limitation level of GB/T26572-2011 standard regulation.

✕: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is above the limitation level of GB/T26572-2011 standard regulation.

## 8. OUTLINE DRAWINGS

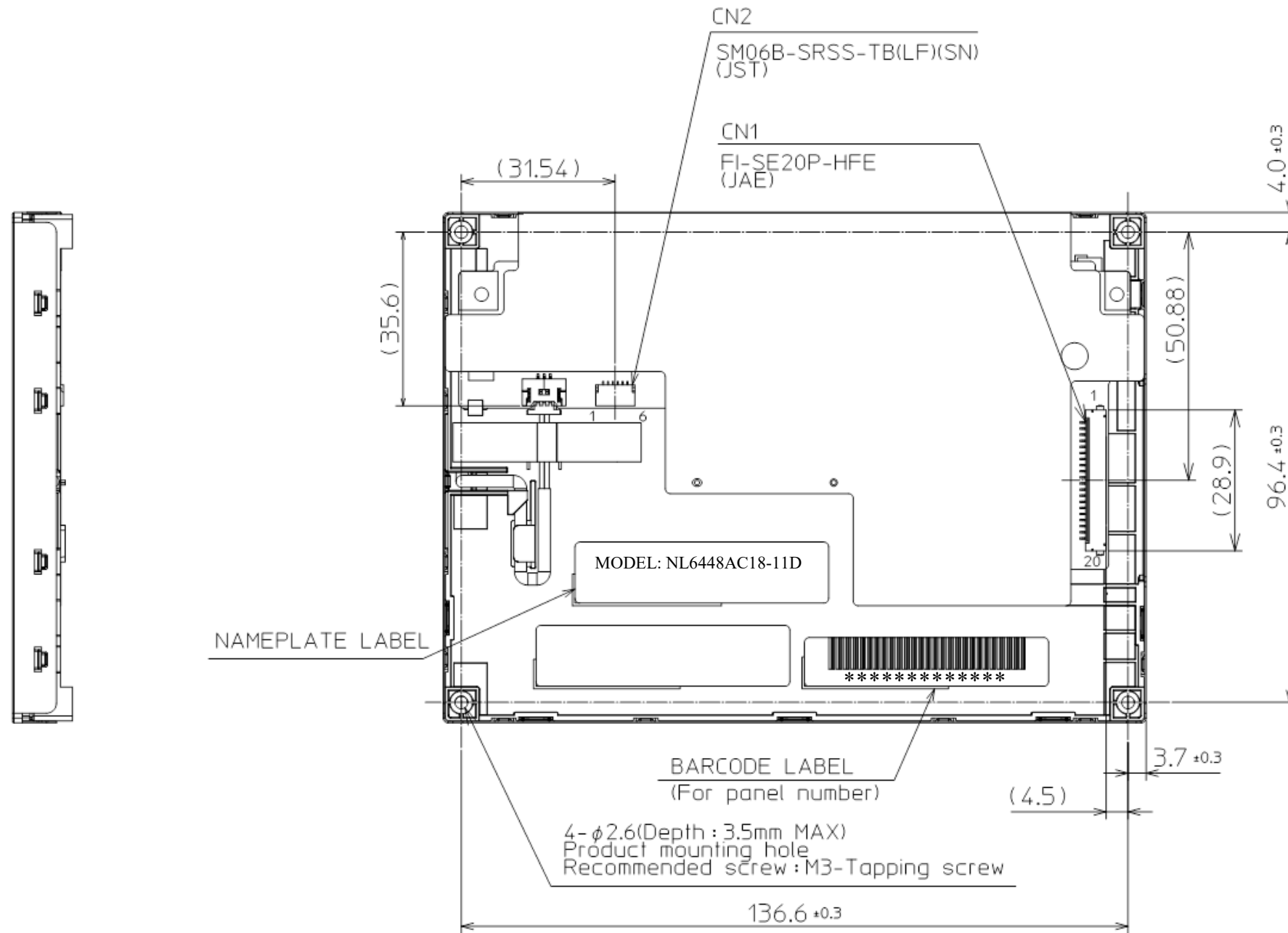### 8.1 FRONT VIEW



118.2 ±0.3 (BEZEL OPENING)

115.2 (DISPLAY AREA)

12.3 ±0.5

(51.1)

DISPLAY AREA CENTER

104.6 ±0.5

(68.3)

86.4 (DISPLAY AREA)

89.4 ±0.3 (BEZEL OPENING)

144.0 ± 0.5

Unit: mm

Note1:  The values in parentheses are for reference.

8.2 REAR VIEW



CN2
SM06B-SRSS-TB(LF)(SN)
(JST)

CN1
FI-SE20P-HFE
(JAE)

(31.54)

(35.6)

(50.88)

4.0 ±0.3

96.4 ±0.3

(28.9)

MODEL: NL6448AC18-11D

NAMEPLATE LABEL

1   6

1

20

BARCODE LABEL
(For panel number)

* * * * * * * * * * * * *

3.7 ±0.3

(4.5)

4-φ2.6(Depth : 3.5mm MAX)
Product mounting hole
Recommended screw : M3-Tapping screw

136.6 ±0.3

Unit: mm

Note1:  The values in parentheses are for reference.
Note2:  The torque for product mounting screws must never exceed 0.200 N·m. And the length of product mounting screws must be ≤ 3.5 mm.

Our company network supports you worldwide with offices in Germany, Austria, Switzerland, the UK and the USA. For more information please contact:

**Headquarters**

**Germany**

FORTEC

ELEKTRONIK AG

**FORTEC Elektronik AG**
Augsburger Str. 2b
82110 Germering

Phone:    +49 89 894450-0
E-Mail:    info@fortecag.de
Internet:    www.fortecag.de

**Fortec Group Members**

**Austria**

DISTEC
A FORTEC GROUP MEMBER

**Distec GmbH Office Vienna**
Nuschinggasse 12
1230 Wien

Phone:    +43 1 8673492-0
E-Mail:    info@distec.de
Internet:    www.distec.de

**Germany**

DISTEC
A FORTEC GROUP MEMBER

**Distec GmbH**
Augsburger Str. 2b
82110 Germering

Phone:    +49 89 894363-0
E-Mail:    info@distec.de
Internet:    www.distec.de

**Switzerland**

ALTRAC
A FORTEC GROUP MEMBER

**ALTRAC AG**
Bahnhofstraße 3
5436 Würenlos

Phone:    +41 44 7446111
E-Mail:    info@altrac.ch
Internet:    www.altrac.ch

**United Kingdom**

DISPLAY TECHNOLOGY
A FORTEC GROUP MEMBER

**Display Technology Ltd.**
Osprey House, 1 Osprey Court
Hichingbrooke Business Park
Huntingdon, Cambridgeshire, PE29 6FN

Phone:    +44 1480 411600
E-Mail:    info@displaytechnology.co.uk
Internet:    www. displaytechnology.co.uk

**USA**

APOLLO DISPLAY TECHNOLOGIES
A FORTEC GROUP MEMBER

**Apollo Display Technologies, Corp.**
87 Raynor Avenue,
Unit 1Ronkonkoma,
NY 11779

Phone:    +1 631 5804360
E-Mail:    info@apollodisplays.com
Internet:    www.apollodisplays.com